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A NEW METHOD OF CRYSTAL DRAWING[1]

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The following method of crystal drawing, unlike all other methods, is not based upon geometrical constructions. In place of geometrical construction lines we have substituted the more general equations of analytical geometry and obtained two simple formulas which are applicable to all forms. These formulas give coördinates which, when plotted on the axial cross (of any system), give at once the direction of the line of intersection. The first part of this article will be devoted to the technical procedure of drawing crystals; the second part to the theory of the method.

PART I. METHOD

The method may be best illustrated by taking a practical example and working it thru. First the axial cross, the construction of which is described in all standard texts, must be drawn. We then have the two formulas

$$b = \frac{hr - lp}{kr - lq}; \qquad c = -\frac{hq - kp}{kr - lq}$$

which give the coördinates of the direction point of the line of intersection between any two faces whose Miller indices are hkl and pqr. For example take the forms 223 and 021, we have

$$b = \frac{2 - 0}{2 - 6}; \qquad c = -\frac{4 - 0}{2 - 6};$$

from which $b = -1/2$ and $c = 1$, which are the coördinates of the direction point.

[1] Read at the meeting of the Mineralogical Society of America, December 29, 1920.

In Fig. 1A, which represents orthorhombic axes, we plot the point d(− 1/2, 1) by going to the left of the origin a distance equal to 1/2b and then vertically a distance equal to c. This point connected with the control point, the positive end of the *a* axis, gives the direction of the line of intersection between the two forms, 223 and 021. Figs. 1B and C show the application of the same coördinates to the triclinic and the hexagonal systems. In all calculations in the hexagonal system we drop out the third number of the Miller indices because three axes determine the position of a face.

Under certain conditions the denominator in the formulas becomes zero, and coördinate values can not be obtained. In this case the origin becomes our control point and the coördinates of the direction point are the numerators of the fractions. The coördinates are then plotted as before, but to obtain the direction of the line of intersection we connect that point with the origin.

Knowing the direction lines between all faces, we construct the crystal drawing by the same method that is followed when using the intersection or the Stöber method. For lines in the rear, one may use the same direction point as used for the corresponding faces in front, but connect that point with the negative end of the *a* axis.

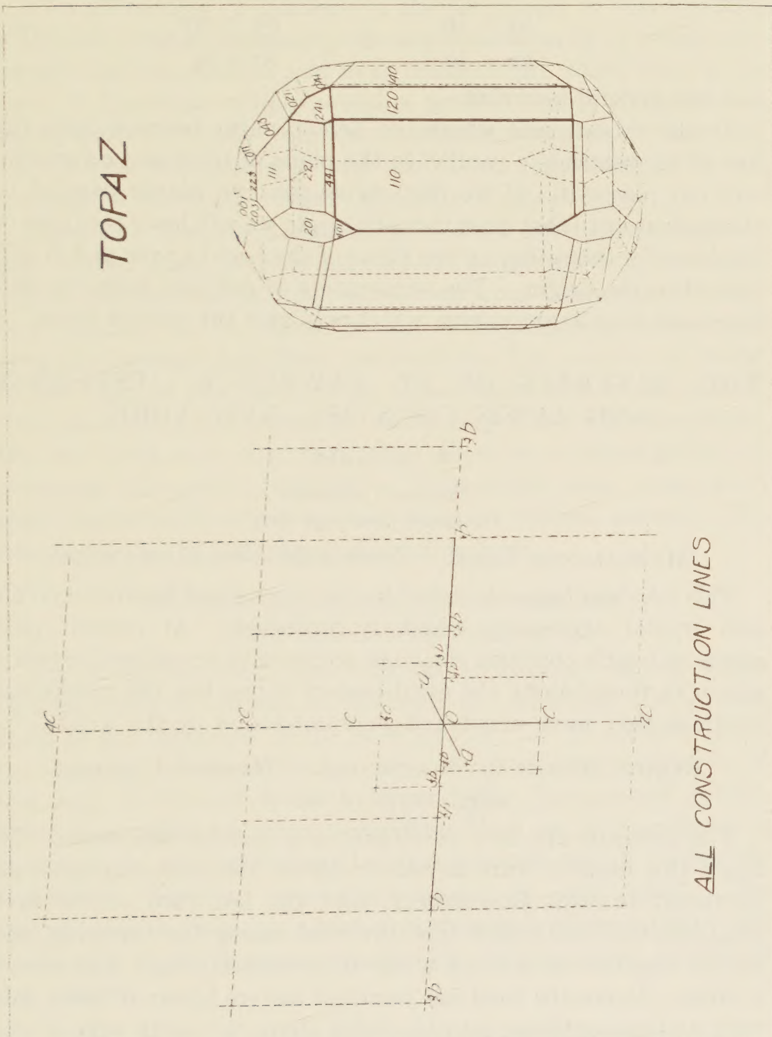
Part II. Principles of the Method

This method of determining the direction of the intersection lines is a mathematical solution of the well-known intersection method under special conditions. Every face is moved parallel to itself until it cuts the *a* axis at unity. Then the positive end of the *a* axis becomes a point on all intersection lines. We then determine by analytical geometry the coördinates of the point at which a line of intersection pierces the plane of the *b* and the *c* axes. This is done as follows:

Let hkl and pqr be any two faces of a crystal. Let the *a*, *b*, and *c* axes represent the coördinate axes x, y, and z. Then write the equations of the two planes parallel to those two faces and passing thru the point x = 1, on the x axis, which gives:

$$hx + ky + lz = h; \qquad px + qy + rz = p.$$

The equation of the plane of the *b* and the *c* axes is x = 0, so if we solve this equation simultaneously with the two equations above we will have the coördinates of the piercing point. The solution gives:


TOPAZ
001
203
223
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021
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120
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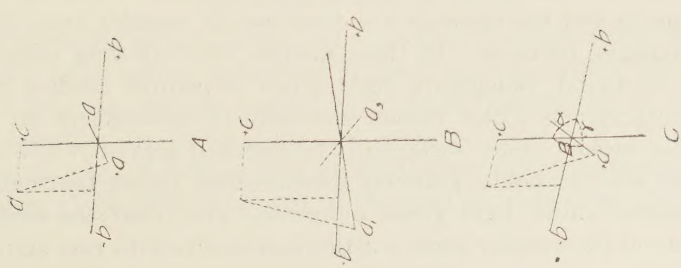
ALL CONSTRUCTION LINES


A
B
C

$$y = \frac{hr - lp}{kr - lq}; \qquad z = - \frac{hq - kp}{kr - lq},$$

our two general formulas.

In the special case where the denominator becomes zero the line of intersection is parallel to the plane of the *b* and *c* axes and will not pierce it. If we then move the two planes parallel to themselves until they pass thru the origin we will have the trace of the line of intersection on the plane of the *b* and *c* axes and it will pass thru the origin. The numerators of our two formulas will represent coördinate values, which will give the correct slope.

THE MINERALS OF ST. LAWRENCE, JEFFERSON AND LEWIS COUNTIES, NEW YORK

W. M. AGAR

Princeton University

(*Continued from page 153*)

Muskalonge Lake. *Hammond*-7-3-southwest edge.

This lake was formerly noted for the large-sized fluorite crystals and crystal aggregates which it furnished. At present pale green to nearly colorless cleavage pieces with occasional crystals are to be found along the northeastern shore, but the cracks out of which they have weathered were not found by the writer.

Region North of Somerville. *Hammond*-9-4-east edge, north of center.

The minerals are here developed in a nodular limestone. To reach this locality start at Somerville on the state road and go northeast towards Gouverneur, take the left turn at the first road junction and follow this dirt road (along the township line on the map) across a creek where it turns sharp right and passes a farm. Leave the road one hundred meters before it takes this turn and go southeast into the fields along the south edge of the woods. The limestone is cut by a few masses of granite and pegmatite but the minerals are developed in nodules away from the igneous contacts. In these nodules the following minerals may be found: phlogopite, light green serpentine holding pale purplish spinels (these cannot generally be seen except on the freshly broken under surface of the nodule), grayish white and brown silky scapolite, granular disseminated brown tourmaline, occasional small, light green pyroxenes, and, near the eastern border of the nodular zone, a little chondrodite with rare spinels.

Two kilometers (1.2 miles) to the southwest of this locality, within the triangle formed by the three roads south of Wegatchie, parallelling the eastern and near the southern road, there is an area of limestone which contains perfect, small, disseminated pale yellow to nearly colorless tourmaline crystals. These are only a few millimeters in size and their crystalline form can scarcely be made out without the help of a good lens.

Three km. (2 m.) northeast of the nodular zone, Hammond-9-2-east central edge, there is a small cut to·the north of the road. This is on the road running southwest from Gouverneur to Oxbow, 4.5 km. (2.9 m.) from the end of the bridge in Gouverneur over the Oswegatchie River, between the first and second farms to the right of the road on the Gouverneur side of the school. The cut is in a white pegmatite which projects thru the limestone. On its north and northeast sides there is a development of pyroxene (diopside), feldspar, a little white mica, some good small hornblende crystals, and granular brown garnet. The hornblende is the best thing obtainable here.

MACOMB. *Hammond*-3-6-east edge, and *Gouverneur*-1-4-west center.

This is on the road from Macomb to Hickory school, 4 km. (2.4 m.) from the church in Macomb, in a line from the seventh farm to the southeast of the road and the "r" in Hickory Lake on the map. Follow this line onto the Gouverneur sheet $\frac{3}{4}$ of the way to Beaver Creek. Beyond the fine-grained gabbro there is a region of white pegmatite dikes cut by quartz veins bearing light and dark brown to black tourmalines, all cutting the limestone. Some of these tourmalines are well zoned. The topography as usual is a series of northeast-southwest ridges and valleys all of which are so nearly alike that no exact directions are possible.

GOUVERNEUR BROWN TOURMALINE LOCALITY. *Gouverneur*-4-3-south center.

This is one of the famous old collecting localities which will be found to be nearly exhausted of good material, altho collectors who want to take the trouble to do some blasting will no doubt be rewarded by opening up new pockets. It is near the upper eastern edge of section four of the Gouverneur quadrangle, 160 meters (1/10 mile) southeast of the road running from the Rock

Island School, roughly parallel to the Oswegatchie River, northeast to Richville; just beyond the seventh farm northeast of the school and immediately west of the narrow dotted road running southeast and east. The pits from which the mineral has been taken are just over the first ridge visible from the road at the farm. Massive brown tourmaline is still abundant, as is silky white tremolite. This latter is also developed as acicular crystals in the limestone surrounding the pits. Next to the tremolite in order of abundance comes diopside, then phlogopite, and pyrite. According to Dana titanite has been found here, but the writer did not see any. A few specks of black tourmaline can be seen in the small knobs of bleached pegmatite located 25 meters north of the line of the pits.

RUSSELL-4-6-east central edge.

About 8 km. (5 m.) south by west of the village of Russell there is a development of danburite. In order to reach this from Russell, take the road starting south and passing over Hamilton Hill to Derby Cors., Whippoorwill Cors., then southwest thru Hughesville School to Edwards. About 8 km. (5 m.) out of Russell on this road, beyond B.M. 686 and the first road to the southeast after Whippoorwill Cors., the farm of Van Buskirk will be found to the southeast of the road. On the bare hilltop south of the junction of the two roads, 0.3 km. (0.2 mile) southeast of one, and the same distance southwest of the other, there is a blasted pit containing large feldspars, pyroxene, and scapolite. Very little can be gathered here without further blasting.

Just southeast of the last locality and 0.8 km. (0.5 m.) back of the Van Buskirk farm along the southeast-running road and 160 meters southwest of it (at the point where the road takes the first turn) on the high ridge of rusty gneiss the danburite is found. The mineral occurs as large veins by itself, or with quartz and some tourmaline, cutting a green pyroxene rock. This massive danburite which weathers white and opaque is very abundant and good water-clear crystals of small size are found in it. Some large dull crystals may also be found by breaking open the larger blocks on the dump.

PYRITES. *Canton*-7-9-east center.

Two old mica pits are located in the southwest part of section seven of the Canton quadrangle, 2.5 km. (1½ m.) southeast from

the bridge immediately above the dam in the village of Pyrites, on the road north of Grass River, and 160 meters north of this road (on the south tip of the granite mass on the geological map). The most noticeable mineral here is the mica, phlogopite, which was mined not many years ago and a good deal of which still lies on two dumps. The pits from which the mica was taken are within 60 meters of each other and the hanging wall of the upper one is coated with good pyroxene crystals. The observer must get down low and look at the face nearly at the bottom in order to see these. In the pits and on the dumps the following minerals are plentiful: phlogopite—some good hexagonal crystals but mostly irregular plates as much as 12 cm. in diameter; apatite—lustrous light green crystals as much as 5 cm. long, tho mostly broken, occurring intergrown with pyroxene or in a coarse pink to orange calcite which also contains some pyrite; titanite—sparingly in calcite along with the apatite; dodecahedral garnets, abundant in the gneissoid country rock and in a few black tourmaline-bearing pegmatites, found intersecting it.

Pierrepont Black Tourmaline Locality. *Canton*-9-3-near the southwest corner.

This is another famous collecting ground. It is doubtless the locality from which most of the black tourmaline in the mineral collections of the country has come. It is situated on the right bank of Leonard Brook 1.8 km. (1.1 m.) northwest of Pierrepont Crossroads, 1/2 km. (0.3 m.) downstream from the bridge at B.M. 597 on the road running southeast from Crary Mills and off the sheet 1.8 km. (1.1 m.) northeast of Pierrepont. The tourmaline occurs as a band running from the brook intermittently up the hill for about 150 meters. A great many pits have been blasted in it, but it still forms a very conspicuous black band on the slope. Clusters of brilliant black crystals are abundant and doubly terminated, stubby, polar crystals can with care be dug out. They occur with quartz, some calcite, phlogopite, and pyroxene in good square crystals. These grow more abundant as the band is followed up the hill.

Natural Bridge. *Lake Bonaparte*-7-1.

The locality lies in the northwest corner of section seven of the Lake Bonaparte Quadrangle where a corner of Jefferson County projects onto the map. Thirty meters down the Indian River

from the rapids below the cement bridge which in turn is down stream from the entrance to the natural bridge tunnel, on the west bank of the stream, there are some good feldspar crystals, large-sized titanites, and well-formed pyroxenes, accompanied by crystalline calcite. The whole occurs in a tough gray syenite, mostly as loose boulders along the water's edge.

About 0.3 km. (0.2 m.) north of the dam below the natural bridge on the county line between the road and the railroad, there is a limestone quarry set 30 meters back from the road (on the map it lies between the first f in Jefferson Co. and the L of Lewis Co.). On the eastern end of the south face of this quarry there is a pocket of calcite crystals. These are rounded and well-formed rhombohedrons and nail-head spars which are sometimes nearly 1 dm. thick. Near the center of the northern face of the quarry there is a band of dark smoky calcite. Disseminated in the rock alongside of this and particularly in boulders at the base of the quarry face spinel may be found, in clear, well-formed octahedrons of a rich blue color, some as large as 6 mm. They occur in a pure white calcite along with a green serpentinized pyroxene, some pale pink diopside, graphite, phlogopite, and a little reddish brown, silky wollastonite. This latter can be found in greater abundance in the loose boulders north of the open end of the quarry. It occurs as small brown crystals much resembling distorted garnets.

Lake Bonaparte-7-1-east edge.

About 1.6 km. (1 m.) east of the lower artificial bridge in Natural Bridge, along the road to Blanchard School, an old quarry is visible 170 meters south of the road. In a line with the old incline to the furnaces and the larger of the two shacks at the head of the quarry, one hundred meters towards the road from the shack, there is a pit 2 meters deep and 5 m. long on the limestone-syenite contact. This and the adjoining field form one of the noted mineral localities of the neighborhood. They have been pretty thoroly picked over, but in spite of this the following may be found in relative abundance: Pyroxene—massive and green crystalline aggregates with considerable titanite embedded in them; tremolite; wernerite in brown silky aggregates and as small light gray to pink crystals; phlogopite; scapolite (meionite) in silky, light green, stubby crystals developed on the actual contact.

Four tenths km. (¼ m.) back towards the village of Natural Bridge, parallelling the road on a bare hillside, there is an irregular contact one hundred meters long. This is a coarsely crystalline aggregate of feldspar, titanite, and pyroxene forming a striking green and white band with here and there a mat of finely crystalline white to purplish diopside. This contact will still yield some fairly good pyroxene crystals, feldspar, and titanite, but the reported zircons were not found by the writer.

The above list does not by any means exhaust the possibilities of the region, it merely gives a brief account of the best among the localities which the writer visited during the course of a summer. The old localities have been pretty thoroly worked over but still yield good material. The new localities are not distinguished by large-sized specimens but the material is abundant and the close examination of much of the territory is sure to disclose more material. This is particularly true of the area north of Oxbow in the Hammond Quadrangle.

The following associations have been noted for the minerals of the region:

Phlogopite,—perhaps the most widespread of all. It occurs in nearly all the contact zones of the granite region associated with all the other minerals and as scattered grains thruout the limestone.

Pyroxene,—occurs nearly everywhere and is associated with any or all of the other minerals tho generally not with spinel. It varies considerably in color and crystal habit.

Tourmaline,—found in all colors from light brown to black and as zoned crystals. It has a very wide range of occurrence both in pegmatite and quartz dikes and in the limestone. It is found associated with all of the other minerals tho very rarely with chondrodite or spinel.

Graphite,—disseminated everywhere in the limestone and concentrated at the contacts between the limestones and the pegmatites along with quartz and tourmaline.

Apatite,—widespread in all the granite area. Usually occurs associated with phlogopite and pyroxene.

Tremolite,—widely disseminated in the limestone and frequently accompanying tourmaline in the contact zones.

Feldspar,—constantly associated with quartz and tourmaline

in the pegmatite dikes. Also occurs in good crystals at Rossie along with pyroxene, apatite, titanite, and scapolite; also all thru the syenite area around Natural Bridge with titanite, pyroxene, and scapolite.

Titanite,—In the granite area it is confined to the region to the north of Oxbow where it is found with pyroxene, apatite, phlogopite, and brown tourmaline. Around Natural Bridge, in the syenite region, it forms an important part of all contacts.

Chondrodite,—occurs associated with spinel, serpentine, and phlogopite. It has a wide distribution in the area to the north of Oxbow.

Serpentine,—widespread. Occurs usually as an alteration of diopside in the limestone forming an ophicalcite, or replacing chondrodite, in which case it is usually associated with spinel. It occasionally replaces calcite and then possesses a good rhombohedral cleavage.

Spinel,—nearly always associated with chondrodite or serpentine or both. It is found with pyroxene in only one locality.

Danburite,—occurs only in one region in veins which are either massive or full of vugs. These cut a green pyroxene rock and are accompanied by quartz and tourmaline.

Garnet,—occurs as a constituent of some of the Grenville gneisses and in zones surrounding the fine-grained granites.

NOTES AND NEWS

A diamond weighing 20¼ carats, the largest yet found in the region, was obtained in the Arkansas mines early in October.

A recent press dispatch from Constantinople concerning Russian refugees included the following: "Prince Golitzyn, who formerly held immense estates near Kiev . . . is courageously attempting to earn a living by utilizing his knowledge of precious stones, of which he once had a large collection."

Professor Viktor von Lang, of the University of Vienna, who was being aided by contributions from a number of Fellows and Members of the Mineralogical Society of America, died during July, at the age of eighty-three.

Professor Charles Palache, President of the Mineralogical Society of America, and Fred. E. Wright, a Councilor of the Society, are to be members of the Shaler Memorial Expedition to South Africa. They expect to leave this country about the first of December. Other members of the party are to be Professor R. A. Daly, of Harvard University, and Professor G. A. F. Molengraaf, of Holland. During Professor Palache's absence the courses in mineralogy and petrography at Harvard are to be given by Mr. J. L. Gillson.

PROCEEDINGS OF SOCIETIES

THE PHILADELPHIA MINERALOGICAL SOCIETY

Academy of Natural Sciences of Philadelphia, September 8, 1921

A stated meeting of the society was held on the above date, Dr. Hawkins presiding, and ten members and four visitors being present. The minutes of the last meeting were read and approved. Messrs. William T. Clay and Elbert W. Chalfont were nominated for active membership. It was voted to defer nomination of officers to the next meeting.

Mr. Oldach reported a trip to the Falls of French Creek Mine, September 3–5, taken by Messrs. Frankenfield, Hagey, Jones, Trudell and himself. Besides the usual run of minerals, titanite, pyroxene, wernerite and microscopic heulandite were found.

Mr. Frankenfield described a two weeks' trip to mineral localities of Massachusetts, Rhode Island and Connecticut. Some of the minerals obtained on this trip were exhibited: fibrous quartz and green talc from Providence, R. I.; microcline crystals from Bradford, R. I.; calcite from Meriden, Ct.; datolite from Springfield, Mass.; black tourmaline and cream-colored anthophyllite from the Pelham asbestos mine. From Strickland's Quarry, Portland, Ct., terminated black tourmaline, quartz with albite inclusions, spodumene, lepidolite and a 7 x 12 cm. columbite crystal.

Mr. Knabe reported a trip to Leiper's quarry and Lenni, finding hematite at the latter. Mr. Oldach reported trips to Boothwyn and Bryn Mawr with negative results. Mr. Warford, having made a trip to the farm of a Mr. Barr near Valley Forge, had invited Mr. Barr to attend and describe the mineral occurrences there.

Dr. Hawkins described some of his recent crystallographic work, and presented a split quartz boulder with tourmalines on its surface to the Academy collection.

John S. Frankenfield, *Secretary pro tem.*

NEW MINERAL NAMES

FAMILY 4. OXIDES, ETC.

PICROCHROMITE; new species and subspecies arrangement in spinel-chromite group

Edward S. Simpson: A graphic method for the comparison of minerals with four variable components forming two isomorphous pairs. *Min. Mag.*, **19**, 99–106, 1920.

Name: Evidently from the Greek *pikros*, bitter, referring to the bitter taste of magnesium salts, and *chromite*.

Physical properties: Presumably intermediate between those of chromite and those of spinel.

Chemical properties: The name is proposed for members of the isomorphous spinel-chromite series approaching the composition $MgCr_2O_4$, the theory for which is: MgO 21.0, Cr_2O_3 79.0 per cent. The only analysis in the literature falling near this is one by T. Sterry Hunt of a "chromite" from Lake

Memphremagog, Canada (Logan's *Rept. Geol. Canada*, 1849). As recalculated by Simpson to allow for ferric iron wihch was not determined but must have been present, to bring the ratio of RO : R_2O_3 to 1 : 1, this gives: MgO 18.13, FeO 6.48, Fe_2O_3 16.45, Al_2O_3 11.30, Cr_2O_3 49.75, sum 102.11 per cent. Two other analyses on record, one of "magnesiochromite" from Dun Mt., N. Z., by T. Petersen (1869) and one of the same material from New Caledonia by E. Glasser (1904), also fall within this species, but in a subspecies lying toward chromite proper, here termed "chrompicotite."

Discussion: The above is one of the species in a proposed new treatment of the spinel-chromite group, which is divided as follows: (Modified from original by abstractor).

Species	Subspecies	Formula range, in 4 molecules ($4RO.4R_2O_3$)								Dominant RO: R_2O_3
		Mg	Fe to	Mg	Fe	Al	Cr to	Al	Cr	
Spinel	Spinel	4	0	3	1	4	0	3	1	—
Spinel	Ceylonite	3	1	2	2	4	0	2	2	<1
Spinel	Magnochromite	4	0	2	2	3	1	2	2	>1
Hercynite	Hercynite	0	4	1	3	4	0	3	1	—
Hercynite	Picotite	2	2	1	3	4	0	2	2	<1
Hercynite	(unknown)	2	2	0	4	3	1	2	2	>1
Chromite	Chromite	0	4	1	3	1	3	0	4	—
Chromite	(unknown)	2	2	0	4	2	2	1	3	>1
Chromite	Beresofite	2	2	1	3	2	2	0	4	<1
Picrochromite	Picrochromite	4	0	3	1	1	3	0	4	—
Picrochromite	Chrompicotite	2	2	3	1	2	2	0	4	<1
Picrochromite	(unknown)	4	0	2	2	2	2	1	3	>1

These relations are best brought out by plotting in a rectangular diagram (see orig.). The only dependable analyses found in the literature, 13 in number, are recalculated and assigned to species and subspecies on this basis. A new occurrence of spinel near Namban, W. Australia, is described, with 2 analyses which show it to fall into the subspecies ceylonite. E. T. W.

DISCREDITED SPECIES

FAMILY 5. CARBONATES

Rosasite

C. Perrier: The true nature of rosasite. *Rend. Accad. Lincei*, **30**, 119, 1921.

A new analysis gave: H_2O 8.58, CO_2 20.18, CuO 41.58, ZnO 28.96, PbO 0.23, NiO 0.04, MgO 0.21, Fe_2O_3 0.31, insol. 0.18, sum 100.27 per cent. This yields the ratio $H_2O : CO_2 : R''O = 1.04 : 1 : 1.93$, corresponding to a zinciferous malachite, (Cu, Zn) CO_3.(Cu, Zn) $(OH)_2$. [This analysis seems to the abstractor more correct than the previous one, on the basis of which this mineral had been announced as a new species; see Dana App. II, p. 80.]

H. S. Washington.